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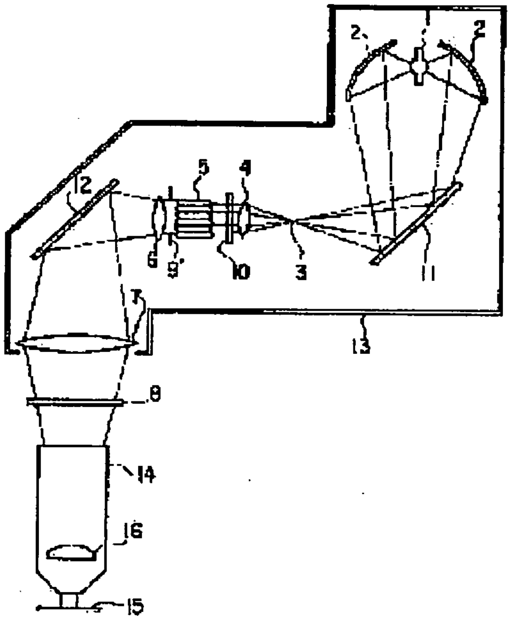
(54) PROJECTION ALIGNER

(57)Abstract:

PURPOSE: To sufficiently increase the depth of focus of the title aligner even when the size of an L/S pattern is large and to enhance the exposure accuracy of the title aligner.

CONSTITUTION: In a projection aligner, a pattern on a mask is projected and exposed onto a wafer via a projection optical system. In the projection aligner, a special disphragm 9' (a four port filter) by means of which the distribution of the intensity inside a radiation face of a light source is symmeteric, four times, with respect to an optical axis and which makes the intensity large in four regions outside the optical axis is installed as a secondary light source with which the mask R is irradiated, and a pattern by using a semitransparent film is formed on a lighttransmitting substrate. Then, the following halftone mask is used: the phase difference between light transmitted through the semitransparent film and light transmitted through the light-transmitting substrate satisfies the relationship of $180\times(2n+1)\pm30^\circ$ [where (n) is an integer]; and the amplitude transmission factor of the semitransparent film satisfies the relationship of $0.01\times T0\leq T\leq 0.30\times T0$ with reference to the amplitude transmission factor of the light-transmitting substrate.



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CLAIMS

[Claim(s)]
[Claim 1] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, to an optical axis, it is symmetrical with 4 times, and cheats out of the intensity distribution within a injection side of this light source as a size on the strength in four fields from which it separated from the optical axis. As said mask The phase contrast over the light which passes the translucency substrate of the light which the pattern of a semi-transparent membrane is formed on a translucency substrate, and passes this semi-transparent membrane 180x(2n+1)**30(degree):n fills the relation of integer **, and the amplitude transmittance T of a semi-transparent membrane is the amplitude transmittance T0 of a translucency substrate. Projection aligner characterized by using what receives and fills 0.01xT0 <=T<=0.30xT0.
[Claim 2] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, to an optical axis, it is symmetrical with 4 times, and cheats out of the intensity distribution within a injection side of this light source as a size on the strength in four fields from which it separated from the optical axis. As said mask A pattern is formed with a shading film on a translucency substrate, and the translucency film is arranged in the part except the perimeter or perimeter of a pattern by this light-shielding film. For 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which passes this translucency film is the projection aligner with which it is characterized by using what fills the relation of integer **.
[Claim 3] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, to an optical axis, it is symmetrical with 4 times, and cheats out of the intensity distribution within a injection side of this light source as a size on the strength in four fields from which it separated from the optical axis. As said mask A pattern is formed with the translucency film on a translucency substrate at least at a part. For 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which passes the pattern by this translucent membrane is the projection aligner with which it is characterized by using what fills the relation of integer **.
[Claim 4] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, to an optical axis, it is symmetrical with 4 times, and cheats out of the intensity distribution within a injection side of this light source as a size on the strength in four fields from which it separated from the optical axis. The projection aligner characterized by having arranged the substrate which has the translucency over exposure light in the pupil location of said projection optics, and giving distribution to it at the thickness or the refractive index of this substrate.
[Claim 5] The 1st condensing optical system which condenses the light from the light source, and the equalization optical system which equalizes the light condensed by this 1st condensing optical system, The special diaphragm prepared in the surface-of-light-source location by the side of the outgoing radiation of this equalization optical system, and the 2nd condensing optical system which condenses the light obtained through this special diaphragm, and irradiates a mask, In the projection aligner which imprints on a wafer the pattern which possessed the projection optics which projects on a wafer the light which penetrated the mask, and was formed in the mask said special diaphragm Four fields out of which it cheats as a size on the strength in four fields which the core of a schematic-drawing form was on the concentric circle centering on an optical axis, and were symmetrical with 4 times and separated from the intensity distribution within a surface of light source

from the optical axis to the optical axis and where the radius vector direction is comparatively large, The projection aligner characterized by being what consists of a field which combines these four fields, and where the radius vector direction is comparatively narrow.
[Claim 6] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, the intensity distribution within a injection side of this light source are made into a size on the strength to an optical axis in four fields from which were symmetrical with 4 times and it separated from the optical axis, and reinforcement for a core of the light source is made into size. As said mask The phase contrast over the light which passes the translucency substrate of the light which the pattern of a semi-transparent membrane is formed on a translucency substrate, and passes this semi-transparent membrane 180x(2n+1)**30(degree):n fills the relation of integer **, and the amplitude transmittance T of a semi-transparent membrane is the amplitude transmittance T0 of a translucency substrate. Projection aligner characterized by using what receives and fills 0.01xT0 <=T<=0.30xT0.
[Claim 7] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, the intensity distribution within a injection side of this light source are made into a size on the strength to an optical axis in four fields from which were symmetrical with 4 times and it separated from the optical axis, and reinforcement for a core of the light source is made into size. As said mask A pattern is formed with a shading film on a translucency substrate, and the translucency film is arranged in the part except the perimeter or perimeter of a pattern by this light-shielding film. For 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which passes this translucency film is the projection aligner with which it is characterized by using what fills the relation of integer **.
[Claim 8] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics As the light source which illuminates said mask, the intensity distribution within a injection side of this light source are made into a size on the strength to an optical axis in four fields from which were symmetrical with 4 times and it separated from the optical axis, and reinforcement for a core of the secondary light source is made into size. As said mask A pattern is formed with the translucency film on a translucency substrate at least at a part. For 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which passes the pattern by this translucent membrane is the projection aligner with which it is characterized by using what fills the relation of integer **.
[Claim 9] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics The intensity distribution of the light source which illuminates said mask are made into a size on the strength in two symmetrical fields on both sides of one field or optical axis which separated from the optical axis. The projection aligner characterized by considering as permeability size along the diameter direction of a pupil including the field which serves as a size of said light source on the strength on this pupil in permeability distribution of the pupil of said projection optics, and carrying out synchronous rotation a core [an optical axis] while exposing the intensity distribution of said light source, and permeability distribution of said pupil.
[Claim 10] In the projection aligner which carries out projection exposure of the pattern of a mask on a wafer through projection optics To an optical axis, it is symmetrical with 4 times, and the intensity distribution of the light source which illuminates said mask are made into a size on the strength in four fields from which it separated from the optical axis. The projection aligner characterized by considering as permeability size in rectangular the direction of the side or the direction of the diagonal line which consists of four fields which serve as a size of said light source on the strength on this pupil, and carrying out synchronous rotation of the permeability distribution of the pupil of said projection optics a core [an optical axis] while exposing the intensity distribution of said light source, and permeability distribution of said pupil.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the projection aligner for forming the detailed resist pattern which manufacture of a semiconductor integrated circuit takes.
[0002]
[Description of the Prior Art] In recent years, an advance of an optical lithography technique is remarkable and possibility that 0.5-micrometer Ruhr would also be realizable in the projection aligner of g line (436nm) or i line (365nm) came out. This is because high NA-ization of a lens progressed [high performance-ization of a projection aligner, and] especially. However, it is a question whether next-generation 0.3-micrometer Ruhr can also be attained by old extension. Although resolution improves by a raise in NA of a lens, and short wavelength-ization of exposure light, since the depth of focus falls, usable resolution seldom improves. Therefore, development of the improvement technique of the depth of focus is desired.
[0003] The outline configuration of the projection aligner generally conventionally used for drawing 23 is shown. In this drawing, an ellipse reflecting mirror and 3 the lamp with which 1 consists of a mercury-vapor lamp, and 2 The 2nd focus of the ellipse reflecting mirror 2, An input lens and 5 4 An optical integrator (eye lens to obtain), 6 a collimation lens and 8 for an output lens and 7 A reticle (mask), The filter for letting only the light of the wavelength by which, as for 9, the aperture diaphragm as a homogeneity diaphragm is carried out, and, as for 10, aberration amendment of the optical system is carried out pass, It is the diaphragm as which the projection optics which 11, the cold mirror which 12 bends an optical path and makes the height of equipment low, and 13 project the image of the pattern on a reticle 8 on a lamp house, and projects 14 on a wafer with a lens, a mirror, or its combination, and 15 determine a wafer, and 16 determines numerical aperture.
[0004] Although a large number also besides having been shown in drawing 23 , the basic configuration of the conventional projection aligner is arranged in order of the light source 1, the 1st condensing optical system 18, the equalization optical system 19, the 2nd condensing optical system 20, a reticle 8, projection optics 14, and a wafer 15, as typically shown in drawing 24 (a). The 1st condensing optical system 18 is a part which is equivalent to the ellipse reflecting mirror 2 and the input lens 4 in the example of drawing 23 , arranges suitably a spherical mirror besides an ellipse mirror, a plane mirror, a lens, etc., and has the duty which puts as efficiently as possible the flux of light which comes out of the light source into the equalization optical system 19. Moreover, the equalization optical system 19 is a part equivalent to the optical integrator 5 of drawing 23 , and an optical fiber, polyhedron prism, etc. may be used as others.
[0005] The 2nd condensing optical system 20 is a part equivalent to the output lens 6 and the collimation lens 7 of drawing 23 , makes the outgoing radiation light of the equalization optical system 19 superimpose, and secures image surface tele cent rucksack nature further. In addition, the reflecting mirror which the filter equivalent to the filter 10 of drawing 23 is inserted in a part with the flux of light near optical-axis parallel, and is equivalent to cold mirrors 11 and 12 is also inserted although a location is not the most important.
[0006] Thus, when the side by which light comes from a reticle 8 in the constituted equipment is seen, the property of light turns into a property of the light which comes out from the equalization optical system 19 through the 2nd condensing optical system 20, and the outgoing radiation side of the equalization optical system 19 sees it, and it is visible to the upper light source. For this reason, in the above configurations, generally, outgoing radiation side 24 of the equalization optical system 19 is called the secondary light source. When a reticle 8 is projected on a wafer 15, a formation property, i.e., the resolution, the depth of focus, etc. of a

projection exposure pattern are decided by the description of the light which irradiates the numerical aperture and reticle 8 of projection optics 14, i.e., the description of the secondary light source 24.
[0007] Drawing 24 (b) is an explanatory view about the reticle illumination-light line in the projection aligner shown in this drawing (a), and an image formation beam of light. In drawing 24 (b), projection optics 14 has the aperture diaphragm 16 inside usual, and it has determined the include angle theta of the beam of light which carries out an incident light on the wafer 15 while it regulates include-angle thetaa which the light which passed along the reticle 8 may pass.
[0008] Generally, what is called the numerical aperture NA of projection optics is an include angle defined by NA=sintheta, and when a projection scale factor is set to 1/m, it has the relation of sinthetaa=sin theta/m. Moreover, usually the chief ray which falls to "an image surface tele cent rucksack, i.e., the image surface," in this kind of equipment is constituted at right angles to the image surface, and in order to fulfill the conditions of this "image surface tele cent rucksack", image formation of the real image of the outgoing radiation side of the equalization optical system 19 of drawing 24 (a), i.e., the surface of light source of the secondary light source 24, is carried out to the location of an aperture diaphragm 16.
[0009] The light which carries out incidence to a reticle 8 carried out the range of the solid angle when seeing a secondary surface of light source through the 2nd condensing optical system 20 from a reticle 8 under such conditions, and it was caught, and when the half width was set to phi and sigma=sin phi/sinthetaa defined the coherency sigma of the illumination light, I thought that a pattern formation property was determined by NA and sigma.
[0010] Next, the relation of NA and sigma, and a pattern formation property is explained to a detail. Although resolution goes up so that NA is large, the depth of focus becomes shallow and reservation of an extensive exposure field becomes difficult for the aberration of projection optics 14. Since it cannot use for applications, such as actual LSI manufacture, if there is none of a certain amount of exposure fields and depth of focuses (for example, 10mm angle, **1 micrometer), with conventional equipment, about NA=0.35 is a limitation. On the other hand, a sigma value mainly participates in resolution with a cross-section configuration and correlation with regards to a pattern cross-section configuration and the depth of focus. Although a side attachment wall approaches perpendicularly and a cross-section configuration turns into a good pattern configuration since the deep pool of a pattern will be emphasized if a sigma value becomes small, the focusing range which the definition in a fine pattern worsens and can be resolved becomes narrow. On the contrary, if a sigma value is large, the definition in a fine pattern and the focusing range which can be resolved will become good a little, but the side-attachment-wall inclination of a pattern cross section is loose, and when it is a thick resist, a cross-section configuration serves as a trapezoid thru/or a triangle.
[0011] For this reason, in the conventional projection aligner, as a sigma value which maintained balance comparatively, a fixed setup is carried out sigma=0.5-0.7 and the conditions of sigma=0.3 grade are tried experimentally. In order for what is necessary to be just to decide the magnitude of the surface of light source of the secondary light source 24 to set up a sigma value, generally the circular aperture diaphragm 9 for a sigma value setup is placed just behind the surface of light source of the secondary light source 24.
[0012] The example using the special diaphragm which has a special opening pattern instead of the circular aperture diaphragm 9 as one approach of raising the depth of focus of such a common projection aligner is proposed (the mechanical test [/ in Ukita and a crossing] in "research [of a microscope objective lens] (10th news)" 1957 some places news, the 11th volume, No. 2, p9-). When the filter shown in drawing 2525 (a) is used for a thing characteristic in this, the direction to which two light transmission fields are connected is that having very high definition ability to the last shipment pattern arranged in perpendicularly is described.
[0013] The filter which has four openings as this modification on the other hand as shown in drawing 25 (b) (4th filter is called hereafter) is proposed (Japanese Patent Publication No. 56 No. -9010 official report), and the projection exposure using 4th filter of this form At the 52nd Japan Society of Applied Physics academic lecture meeting in October, 1991, "the reduced-projection-exposure method (I) and (II)" (lecture number 12 a-ZF -3 and 12 a-ZF -4) using the deformation light source were entitled by Kamon, Miyamoto, etc., and it was announced. According to this, the high definition ability to last shipment doubling not only an one direction but a direction right-angled to it, and being obtained is shown.
[0014] Drawing 26 shows the result of having usually carried out simulation of the imprint property in lighting to the case where it illuminates with this 4th filter. As for an axis of abscissa, the ratio of Rhine and a tooth

space shows the last shipment pattern size of 1:1, and the axis of ordinate shows the depth of focus (DOF). NA of 365nm (i line) and projection optics of exposure wavelength is 0.55. Moreover, the resist resolvable at 70% or more of image contrast is assumed. such a last shipment pattern -- setting -- last shipment -- < -- near last shipment=0.4 micrometer, the resolution by 4th lighting and the improvement effectiveness in the depth of focus are usually especially remarkable 0.65 micrometers compared with lighting. However, in last shipment>=0.65micrometer, the direction of the depth of focus in lighting will usually become large compared with 4th lighting conversely.

[0015] Especially, the depth of focus near last shipment=0.7 micrometer is getting worse. It depends for this property on the location of the eye of 4th filter, and magnitude. While the depth of focus of such small last shipment that spacing of an eye separates improves, the inclination for the fall of the depth of focus in big last shipment to become remarkable becomes remarkable. Moreover, an inclination only whose depth of focus of the last shipment pattern of specific size improves is shown, so that an eye is small. Thus, although there are some differences with the location of the eye of 4th filter, and magnitude, an overall inclination is as being shown in drawing 26 .

[0016] moreover, although the above-mentioned explanation came out about the last shipment pattern, at the time of isolated omission pattern formation (at the time of POJIREJISUTO use), 4th filter is an opposite effect rather and it turned out that DOF decreases. The minimum omission line breadth which can secure the depth of focus of 1.5 micrometers will be set to 0.45 micrometers by exposure by 4th lighting to being usually 0.4 micrometers in exposure. That is, in performing exposure by 4th lighting, it means that it is necessary to design an isolated omission pattern by 0.45 micrometers or more to the ability to design the last shipment pattern of 1:1 by 0.29 micrometers. In an actual LSI pattern, although it extracts, and line breadth includes a design rule, near and both sides include several micrometers and there are few typical isolated omission patterns which are resists, there are very many patterns with the small ratio of a tooth space to Rhine. In the case of such so-called isolated omission pattern, the line breadth which can secure the depth of focus of 1.5 micrometers or more becomes large, and it has big effect on the shrink of a chip.

[0017] Moreover, in 4th exposure using 4th filter, good definition ability was not obtained to the pattern arranged in addition to the 2-way which intersects perpendicularly mutually, but it turned out that the fall of definition ability is remarkable about the pattern arranged especially in the direction 45 degrees. The property shown in drawing 26 is the case of relation as 4th filter and the direction of last shipment show to drawing 27 . When 4th filter and the direction of last shipment have the directivity of 45 degrees to relation like drawing 28 , i.e., last shipment, a result [like] is obtained as shown in drawing 29 . In this case, as for an imprint with 4th lighting, compared with lighting, the depth of focus will usually worsen.

[0018]

[Problem(s) to be Solved by the Invention] Thus, compared with exposure by the usual circular secondary light source, resolution and the improvement effectiveness in the depth of focus are remarkable at last shipment<0.65micrometer in the exposure using 4th filter conventionally. However, in last shipment>=0.65micrometer, the direction of the depth of focus in lighting will usually become large compared with 4th lighting conversely. Especially, the depth of focus will be set to about 1.5 micrometers near last shipment=0.7 micrometer. For this reason, in case the big depth of focus imprints a required layer, the pattern near last shipment=0.7 micrometer is not imprinted good. That is, near last shipment=0.4 micrometer, in spite of having the depth of focus of about 2.5 micrometers, there is a problem an imprint property carries out [a problem] rate-limiting with the pattern of bigger size.

[0019] Moreover, when the filter which penetrates light only by four specific places like 4th filter was used as a lighting filter, there was a problem that a big difference arose in definition ability according to the direction of a pattern.

[0020] Moreover, although the depth of focus and resolution of last shipment improve in the above-mentioned conventional example, on the other hand in an isolated omission pattern, the depth of focus and resolution decrease. This shows that it is necessary to design with thick line breadth, so that the Rhine width of face to the tooth-space width of face of a pattern is wide. Since many patterns with the wide Rhine width of face to a tooth space exist, they cannot connect the large depth of focus enhancement effect by 4th lighting with an actual LSI pattern to the shrink of a chip size.

[0021] This invention was made in consideration of the above-mentioned situation, when the size of a last shipment pattern is large, even if there is a place made into the purpose, the depth of focus can be enlarged enough, and it is in offering the projection aligner which can aim at improvement in exposure precision. Moreover, other purposes of this invention are not depended in the direction of a pattern, but are to offer the projection aligner which can enlarge the depth of focus enough.

[0022] Moreover, another purpose of this invention is to offer the projection aligner which an isolated omission-pattern with the wide Rhine width of face can extract to an isolated omission pattern or tooth-space width of face, and can design line breadth more finely, consequently attains shrink with a large chip size.

[0023]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the following configurations are adopted in this invention.

[0024] Namely, this invention (claims 1-3) sets the pattern of a mask to the projection aligner which carries out projection exposure on a wafer through projection optics. The special diaphragm which cheats out of the intensity distribution within a injection side of this light source as a size on the strength to an optical axis as the light source which illuminates a mask in four fields from which were symmetrical with 4 times and it separated from the optical axis is established. It considers as the description using the halftone mask, the self-align mold phase shift mask, or the shifter edge mold phase shift mask as a mask. Here, for 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which the pattern of a semi-transparent membrane is formed on a translucency substrate, and passes this semi-transparent membrane fills the relation of integer **, and the amplitude transmittance T of a semi-transparent membrane is [a halftone mask] the amplitude transmittance T0 of a translucency substrate. It receives and 0.01xT0 <=T<=0.30xT0 is filled.

[0025] A pattern is formed with a shading film on a translucency substrate, a self-align mold phase shift mask arranges the translucency film in the part except the perimeter or perimeter of a pattern by this light-shielding film, and, as for 180x(2n+1)**30(degree):n, the phase contrast over the light which passes the translucency substrate of the light which passes this translucency film fills the relation of integer **.

[0026] As for 180x(2n+1)**30(degree):n, the phase contrast over the light in which a shifter edge mold phase shift mask passes the translucency substrate of the light which a pattern is formed with the translucency film on a translucency substrate at least at a part, and passes the pattern by this translucent membrane fills the relation of integer **.

[0027] Moreover, this invention (claim 4) sets the pattern of a mask to the projection aligner which carries out projection exposure on a wafer through projection optics. The special diaphragm which cheats out of the intensity distribution within a injection side of this light source as a size on the strength to an optical axis as the light source which illuminates a mask in four fields from which were symmetrical with 4 times and it separated from the optical axis is established. The substrate which furthermore has the translucency over exposure light in the pupil location of projection optics is arranged, and it is characterized by giving distribution to the thickness or the refractive index of this substrate.

[0028] It is desirable to change the thickness or the refractive index of a substrate equivalent to the periphery of a pupil to other parts here in the substrate arranged in the pupil location of projection optics. Moreover, it is more desirable to use said halftone mask, a self-align mold phase shift mask, or a shifter edge mold phase shift mask in addition to the above-mentioned configuration.

[0029] Moreover, the 1st condensing optical system to which this invention (claim 5) condenses the light from the light source, The equalization optical system which equalizes the light condensed by this 1st condensing optical system, and the special diaphragm prepared in the surface-of-light-source location by the side of the outgoing radiation of this equalization optical system, In the projection aligner which imprints on a wafer the pattern which possessed the 2nd condensing optical system which condenses the light obtained through this special diaphragm, and irradiates a mask, and the projection optics which projects on a wafer the light which penetrated the mask, and was formed in the mask Four fields out of which it cheats as a size on the strength in four fields which the core of a schematic-drawing form was on the concentric circle centering on an optical axis as a configuration of a special diaphragm, and were symmetrical with 4 times and separated from the intensity distribution within a surface of light source from the optical axis to the optical axis and where the radius vector direction is comparatively large, It is characterized by constituting so that it may have the field which combines these four fields and where the radius vector direction is comparatively narrow.

[0030] Moreover, this invention (claims 6-8) sets the pattern of a mask to the projection aligner which carries out projection exposure on a wafer through projection optics. The special diaphragm which made the intensity distribution within a injection side of this light source a size on the strength to the optical axis as the light source which illuminates a mask in four fields from which were symmetrical with 4 times and it separated from the optical axis, and made reinforcement for a core of the light source size is established. As a mask It considers as the description using a halftone mask, a self-align mold phase shift mask, or a shifter edge mold phase shift mask.

[0031] Moreover, this invention (claim 9) sets the pattern of a mask to the projection aligner which carries out projection exposure on a wafer through projection optics. The intensity distribution of the light source which illuminates a mask are made into a size on the strength in two symmetrical fields on both sides of one field or optical axis which separated from the optical axis. It considers as permeability size along the diameter direction of a pupil including the field which serves as a size of the light source on the strength on this pupil in permeability distribution of the pupil of projection optics, and while exposing the intensity distribution of the light source, and permeability distribution of a pupil, it is characterized by carrying out synchronous rotation a core [an optical axis].

[0032] Moreover, this invention (claim 10) sets the pattern of a mask to the projection aligner which carries out projection exposure on a wafer through projection optics. To an optical axis, it is symmetrical with 4 times, and the intensity distribution of the light source which illuminates a mask are made into a size on the strength in four fields from which it separated from the optical axis. It is characterized by considering as permeability size in rectangular the direction of the side or the direction of the diagonal line which consists of four fields which serve as a size of the light source on the strength on this pupil, and carrying out synchronous rotation of the permeability distribution of the pupil of projection optics a core [an optical axis], while exposing the intensity distribution of the light source, and permeability distribution of a pupil.

[0033]

[Function] When carrying out a pattern imprint as light source intensity distribution in the lighting which the reinforcement in four fields from which are point symmetry and it separated from the optical axis becomes size to an optical axis according to this invention (claims 1-3), it is possible by using a halftone mask, a self-align mold phase shift mask, a shifter edge mold phase shift mask, etc. to enlarge further the improvement effectiveness in DOF of the last shipment pattern of all sizes. Although there is an inclination for the depth of focus of a large last shipment pattern to become small relatively compared with small last shipment, like the case where the usual Cr mask is used, in having only used 4th filter as the light source, the depth of focus as an absolute value can be raised by having used the various above-mentioned phase shift masks.

[0034] Moreover, according to this invention (claim 4), while using 4th filter as the light source, by arranging the substrate which has translucency to exposure light in the pupil location of projection optics, and changing the thickness or the refractive index of a substrate equivalent to the periphery of this pupil to other parts, it cannot be dependent on pattern size and the big depth of focus and the improvement effectiveness in marginal resolution can be acquired. In addition, it is possible to use a halftone mask and a phase shift mask for a mask, and to enlarge the above-mentioned effectiveness more by things.

[0035] Moreover, according to this invention (claim 5), the special diaphragm as the light source has the configuration of two kinds of filters of a zona-orbicularis lighting filter and 4ths lighting filter, consequently both fault negates each other, pattern size and the dependency of a direction can be reduced to the level which is satisfactory practically, and high definition ability and the improvement effectiveness in the depth of focus are acquired.

[0036] Like [according to this invention (claims 6-8)] claims 1-3 mentioned above, moreover, as light source intensity distribution The reinforcement in four fields from which it separated from point symmetry and an optical axis to the optical axis size in addition to the depth of focus of the last shipment pattern in the case of imprinting in the becoming lighting, and the improvement effectiveness in marginal resolution, by enlarging light source reinforcement near the core of the light source The depth of focus and resolution over an isolated omission pattern can also be raised. Consequently, it becomes possible to attain shrink with a large chip size.

[0037] Moreover, according to this invention (claims 9 and 10), by arranging the filter which has aperture in the location which carried out eccentricity to the light source location of an aligner from the optical axis, and cheating as the illumination-light study system which illuminates a mask from across, the high order diffracted light of the long last shipment pattern of the eccentric direction and a right-angled direction goes into projection optics, and resolution improves. Here, since actual LSI has various directivity, the high order diffracted light generated from patterns other than the above-mentioned direction does not go into a pupil, and its definition does not improve. Therefore, the diffracted light generated from patterns other than the above-mentioned direction is positively cut for arranging in a pupil location the slit which doubled the eccentric direction of this filter with the longitudinal direction. Furthermore, the pattern directivity dependency of resolution is cancelable by exposing this slit and this filter, setting a revolving shaft as an optical axis and carrying out synchronous rotation 360 degrees.

[0038] moreover -- as the filter arranged in a light source location -- the eccentricity from an optical axis -- carrying out -- and an optical axis -- receiving -- mutual -- the symmetry -- it is possible to have the same resolution as the above-mentioned exposure approach, and to make the exposure time into one half by using for a location the filter which has every one a total of two aperture. Furthermore, it is possible for it to be symmetrical with 4 times to an optical axis, to have the almost same resolution as the above-mentioned exposure approach by using the slit filter out of which it cheats as permeability size for example, in the shape of parallel crosses in the pupil location of projection optics using the filter out of which it cheats as a size on the strength in four fields from which it separated from the optical axis, and to shorten the exposure time further as a filter arranged in a light source location.

[0039]

[Example] Hereafter, the example of illustration of the detail of this invention explains.

[0040] Drawing 1 is the outline block diagram showing the projection aligner concerning the 1st example of this invention. In drawing 1 1 an ellipse reflecting mirror and 3 for a lamp (light source) and 2 The 2nd focus of the ellipse reflecting mirror 2, 4 an optical integrator and 6 for an input lens and 5 An output lens, The special diaphragm in which 7 has a collimation lens in permeability and, as for 8, a reticle and 9' have distribution, 10 is a diaphragm as which a filter, the projection optics to which a cold mirror and 13 project the image of the pattern on a reticle 8 on a lamp house, and 11 and 12 project 14 on a wafer with a lens, a mirror, or its combination, and 15 determine a wafer, and 16 determines numerical aperture, and is called the pupil. It is the filter which has distribution in the optical path length.

[0041] A mercury-vapor lamp is used as a lamp 1 of the light source, and the continuous spectrum of such bright-lines [, such as 436nm of g lines, 405nm of h lines, and 365nm of i lines etc.,] or wavelength neighborhood is taken out and used. For this reason, while high brightness is required for the lamp 1 of the light source, when condensing effectiveness and exposure homogeneity are considered, its direction near the point light source is good. however, the lamp 1 which moreover has distribution in reinforcement in the magnitude of finite in fact since such the ideal light source does not exist -- not using it -- it does not obtain but it becomes a technical problem how the light emitted from such a lamp 1 is changed into a good light of exposure homogeneity efficient.

[0042] With the equipment shown in drawing 1 , a lamp 1 is put on the 1st focus of the ellipse reflecting mirror 2, and the flux of lights are once collected near [2nd focal 3] the ellipse reflecting mirror 2. And the flux of light is mostly changed to the parallel flux of light with the input lens 4 which shares a focal location with the 2nd focus 3 mostly, and it puts into the optical integrator 5. The optical integrator 5 is what bundled many cylindrical lenses, and is also called the eye lens of a fly. the mole cricket of the beam of light with which letting this optical integrator 5 pass is the main factor which raises exposure homogeneity, and the input lens 4 passes along the optical integrator 5 -- the duty which lessens ** and raises condensing effectiveness is made.

[0043] The light which came out of the optical integrator 5 is condensed so that the flux of light which came out of each smallness lens of the optical integrator 5 may be overlapped on a reticle 8 and it may hit with the output lens 6 and the collimation lens 7. Although the beam of light by which incidence was carried out to the optical integrator 5 has the intensity distribution by the location, as a result of being superimposed on the light which comes out of each smallness lens of the optical integrator 5 almost equally, on a reticle 8, exposure reinforcement serves as homogeneity mostly. If the luminous-intensity distribution which carries out incidence to the optical integrator 5 with a natural thing is close to homogeneity, the illumination distribution of the reticle 8 on which outgoing radiation light was made to superimpose will become homogeneity more. Special diaphragm 9' mentioned later has been arranged, and the outgoing radiation side dimension of the optical integrator 5 is decided to be the outgoing radiation side of the optical integrator 5.

[0044] When condensing with the ellipse reflecting mirror 2, using a mercury-vapor lamp as a lamp 1, as the structure of a mercury-vapor lamp shows drawing 1 , it is longwise, and since both ends serve as an electrode, the beam of light of the shaft orientations of a lamp 1 cannot be taken out. Therefore, as shown in drawing 1 , by request, the luminous-intensity distribution included in the core of the optical integrator 5 may fall as an input lens 4 using a convex lens. Then, the cone lens of both convex or plano-convex piece concave may be inserted between the input lens 4 and the optical integrator 5, and luminous-intensity distribution included in the optical integrator 5 may be made more uniform.
[0045] A filter 10 is for optical system to let only the light of the wavelength by which aberration amendment is carried out pass, and cold mirrors 11 and 12 bear the duty which make penetrate a long wavelength light-and-heat line, and the part of a lamp house 13 which can be cooled is made to absorb while they bend an optical path and make the height of equipment low. The light which irradiated the reticle 8 passes along projection optics 14, and the projection exposure imprint of the image of the detailed pattern on a reticle 8 is carried out at the resist on a wafer 15.
[0046] Drawing 2 is the top view showing the opening pattern of the 4th filter 20 as special diaphragm 9' used with this example equipment. In this drawing, the slash section shows the protection-from-light section 23, and to the optical axis 21, four circular openings (light transmission section) 22 are symmetrical with 4 times, and are arranged in the location [optical axis] shifted, respectively. Moreover, the halftone mask mentioned later was used as a mask 8.
[0047] The result of having calculated the focal margin to the pattern size in exposure with 4th filter in this example is shown in drawing 3 . When a dotted line usually imprints the usual Cr mask with lighting (sigma value 0.6), it is exposure when exposure when a continuous line uses the usual Cr mask with 4th lighting, and an alternate long and short dash line perform 4th lighting and use a halftone mask further (this example). In addition, 0.55 and the exposure wave lambda of NA of an aligner are 365nm.
[0048] By performing 4th lighting and using a halftone mask further shows that the depth of focus in all line breadth is improving uniformly. About having the maximum depth of focus near last shipment=0.4 micrometer, and the depth of focus serving as the minimum near last shipment=0.7 micrometer, although it is the same as the case where the usual Cr mask is used, since the depth of focus as an absolute value is improving, practically sufficient depth of focus is obtained also in the pattern with big last shipment size.
[0049] Drawing 4 - drawing 6 are drawings for explaining the mask 8 used with this example equipment. The typical cross-section structure of a halftone mask was shown in drawing 4 (a), optical amplitude distribution was shown in drawing 4 (b), and optical intensity distribution were shown in drawing 4 (c). The LSI pattern is formed with the film [that a halftone mask is translucent to exposure light on the translucency substrate 30 (usually SiO2) (1%<= amplitude-transmittance <=30%)] 31. For the phase of the transmitted light 32 of this film, **30(%):n is [the thickness of a semi-transparent membrane 31] an integer and [0050] whenever [180x (2n+1)] to the phase of the substrate transmitted light 33. It is controlled to fill ******. B which diffracts the substrate transmitted light 33 on a wafer, and is shown in breadth drawing 4 (b) -- on a wafer, although it becomes a profile [like], since the light 32 which penetrates a semi-transparent membrane 31 serves as an opposite phase (profile A), it interferes in it, it is weakened mutually and raises image contrast (profile C).
[0051] Moreover, in the above-mentioned example, when the halftone mask was exposed with 4ths lighting filter, it was shown that effectiveness is large, but even if it uses other phase shift masks, for example, a shifter edge mold phase shift mask, and a self-align mold phase shift mask, big effectiveness arises similarly. The typical cross-section structure of a shifter edge mold phase shift mask was shown in drawing 5 . As for the shifter edge mold phase shift mask, the LSI pattern is formed with the transparent matter 34 (SiO2) to exposure light on the translucency substrate 30 (usually SiO2). For the phase of the transmitted light 35, **30(%):n is [the thickness of this transparent membrane 34] an integer and [0052] whenever [180x (2n+1)] to the phase of the substrate transmitted light 33. It is controlled to fill ******. On a wafer, since the substrate transmitted light 33 and the light 35 which penetrates a transparent membrane 34 serve as an opposite phase, the part equivalent to the edge section of a transparent membrane 34 interferes in it, it is weakened mutually, and forms an umbra. Since the line breadth of a transparent membrane 34 is small, the umbrae in the two edge sections overlap and one umbra is formed.
[0053] Moreover, the typical cross-section structure of a self-align mold phase shift mask was shown in drawing 6 . As for the self-align mold phase shift mask, the LSI pattern is formed with the opaque matter 36 (Cr

etc.) to exposure light on the translucency substrate 30 (usually SiO2). A phase shifter 37 is formed in the perimeter of this opaque film 36 with transparent matter (SiO2 etc.) to exposure light. For the phase of the transmitted light 38, **30(%):n is [the thickness of this phase shifter 37] an integer and [0054] whenever [180x (2n+1)] to the phase of the substrate transmitted light 33. It is controlled to fill ******. Although the above structures attained the above-mentioned optical principle in this example, other mask structures of not limiting this invention and attaining the above-mentioned optical principle are sufficient as this structure.

[0055] Thus, according to this example, in order to determine a light source configuration, the improvement effectiveness in DOF of the last shipment pattern of all sizes can be enlarged by using various phase shift masks as shown in drawing 4 -6 as a mask 8 using the 4th filter 20 as shown in drawing 2 . For this reason, even if it is the case that the size of a last shipment pattern is large, the depth of focus can be enlarged enough, and it becomes possible to aim at improvement in pattern exposure precision.

[0056] Next, the 2nd example of this invention is explained. This example uses 4ths+ pupil filter. 4th filter for determining a light source configuration is the same as that of what is shown in said drawing 2 , and, in addition to this, arranges the phase filter 40 as shown in the pupil location 16 of the projection optics 14 shown in drawing 1 at drawing 7 by this example.

[0057] The phase filter of drawing 7 (a) is a disk form symmetrical with rotation to an optical axis 41, and the diameter is equivalent to the pupil diameter. The quality of the material has translucency to exposure light, and is SiO2. It uses. Only in t, in the zona-orbicularis field 42 of a bore r and width of face d, board thickness is thick rather than the other field 43. That is, it means that the optical path length of light who passes through a field 42 becomes longer than that of a field 43. This optical path length's difference produces and cheats out of the phase contrast of light. r, d, and t are determined depending on the location of line breadth to improve the depth of focus and 4th filter etc. Moreover, although the phase filter which has the thickness distribution shown by drawing 7 (a) was used in this example, this invention is not limited and the configuration of a phase filter may change by the line breadth and the line type whose depth of focus wants to improve.

[0058] Moreover, the phase filter shown in drawing 7 (b) also produces and cheats out of the same effectiveness as said phase filter. Board thickness is that the difference from drawing 7 (a) is thin only t rather than the other field 43 in the zona-orbicularis field 42 of a bore r and width of face d. That is, it means that the optical path length of light who passes through a field 42 is shorter than that of a field 43. since the phase contrast of the light produced according to the optical path length's difference makes 2pi one period -- drawing 7 (a) and (b) -- also in which structure, it is possible to acquire desired phase contrast.

[0059] The result of having calculated the focal margin to the pattern size in the exposure using the 4th filter 20 and the phase filter 40 which have four openings is shown in drawing 8 . It is exposure (4ths filter + pupil filter) by this example when a dotted line usually uses Cr mask usual in exposure (exposure only with 4th filter), and a continuous line, and is exposure (4ths filter + pupil filter + halftone mask) by this example when an alternate long and short dash line uses a halftone mask. In addition, NA of an aligner is [0.6 and the exposure wavelength lambda of 0.55 and the coherence factor sigma] 365nm.

[0060] When the phase filter 40 is inserted in a pupil location, it turns out that the trouble at the time of the improvement effectiveness in the depth of focus becoming large by last shipment>=0.65micrometer, and exposing only with 4th lighting is solved. Furthermore, when the halftone mask shown by drawing 4 is used, it turns out that effectiveness is still larger. Moreover, even if it uses the self-align mold mask and shifter edge which were shown by drawing 5 and drawing 6 , effectiveness is large similarly. since [moreover,] the amplitude transmittance of a pupil function is 100% -- super FREX -- exposure light is absorbed, one, i.e., the filter, of the problem of law, it serves as heat, and the problem which optical system tells that thermal expansion degrades a lifting and imprint precision is not produced. Next, the 3rd example of this invention is explained. This example uses 4ths+ zona-orbicularis filter.

[0061] The configuration of special diaphragm 9' of the secondary surface of light source shown in drawing 1 in this example is shown in drawing 9 , and, as for an optical axis and 52, 51 is [the light transmission section and 53] the protection-from-light sections. This is connected by the light transmission section E of the shape of a ring in which the circular light transmission sections A, B, C, and D which had a large field to the radius vector direction centering on an optical axis had a narrow field to the radius vector direction.

[0062] Moreover, although the boundary which consists of a curve altogether constituted from drawing 9 , it is not necessary to be necessarily a curve and is good also considering the 2nd configuration shown in drawing 10

R> 0 as special diaphragm 9'. Furthermore, the 3rd configuration of special diaphragm 9' does not deviate from the range of this invention as a configuration shown in drawing 11 . The description of the configuration of drawing 11 is in the point that the part of a large field does not become uniform width of face to the radius vector direction, but the connection is intermittent further. In drawing 11 , even A - TA are the light transmission sections.

[0063] Furthermore, in the configuration of the example shown in above-mentioned drawing 9 - drawing 11 , the light transmittance of the light transmission section 52 may not necessarily be 100%, and does not need to be [in / depending on the case / all fields] the same permeability. Moreover, there is also no necessity which is point symmetry. In this example, arrangement and occupancy area of the light transmission section 52 can be suitably changed with the desired definition ability and the dimensional accuracy of a pattern.

[0064] Drawing 12 and 13 show the exposure property at the time of exposing using the special filter shown in drawing 9 . The property and drawing 13 to a last shipment pattern with drawing 12 R> 2 in every direction show the property over a slanting last shipment pattern. The depth of focus when an axis of ordinate makes resist contrast 70%, and an axis of abscissa show the pattern size of last shipment.

[0065] If the depth of focus required for a real device pattern imprint is set to 1.5 micrometers, the last shipment pattern size which can secure this need depth of focus will hardly deteriorate from drawing 12 compared with the case where the special filter which has four openings shown in the conventional example is used. That is, in the case of the conventional example, by this example, it is set to last shipment=0.32micrometer to being last shipment>=0.3micrometer.

[0066] On the other hand, by the slanting last shipment pattern shown in drawing 13 , according to exposure by the conventional example, the pattern size which can secure the need depth of focus is last shipment>=0.7micrometer, and slanting last shipment is understood that it is necessary to design it very thickly. On the other hand, it is equal even if the need depth of focus is securable by last shipment>=0.55micrometer, and it compares in exposure by this example, when it is usually exposure (last shipment>=0.5micrometer). That is, according to this example, maintaining the resolving property which excelled at the time of using the special filter which has four conventional aperture masks, the exposure property of the direction in every direction did not degrade a resolving property so much in slanting last shipment, and enabled large design Ruhr contraction of a slanting last shipment pattern.

[0067] Drawing 12 and the property shown in 13 change with the radius of the circular opening ABCD of the special filter of drawing 9 , a center position, the width of face of the ring-like field E, a bore, and outer diameters. It is necessary to optimize if needed.

[0068] Thus, according to this example, there are high definition ability and the improvement effectiveness in the depth of focus by use of the special filter which has 4ths+ zona orbicularis, and it is effective in reducing the dependency of the effectiveness over the pattern size and the direction which moreover were not acquired conventionally on the level which is satisfactory practically. Moreover, when the halftone mask shown in drawing 4 -6 as a mask, a self-align mold mask, and a shifter edge mold mask are used, depth of focus enhancement effect is still larger.

[0069] Next, the 4th example of this invention is explained. This example uses a halftone mask together in 5th filter and 5th filter. It is fundamentally similar with the 1st example, and the 5th filter 60 as the secondary light source is shown in drawing 14 , and, as for an optical axis and 62, 61 is [the light transmission section and 63] the protection-from-light sections. To an optical axis 61, it is symmetrical with 4 times, and, in addition to four openings A, B, C, and D which separated from the optical axis, has Opening E in the optical-axis 51 neighborhood.

[0070] The result of having exposed usual Cr mask and a usual halftone mask is shown in drawing 15 and 16 using such a filter 60. Drawing 15 shows the resolution and the improvement effectiveness in the depth of focus of Rhine and a tooth space as opposed to the last shipment pattern of 1:1 in a ratio. An axis of abscissa shows pattern size and the axis of ordinate shows the depth of focus (DOF). In addition, NA of 365nm (i-line) and projection optics of exposure wavelength is 0.55.

[0071] Thus, in a last shipment pattern, the improvement effectiveness in the depth of focus by 5ths lighting exposure falls compared with 4ths lighting exposure. However, the minimum line width which can secure the depth of focus of 1.5 micrometers is almost the same as the case of 4ths lighting exposure, and does not have a bad influence on the shrink of a chip size at all. Moreover, depth of focus enhancement effect can be further enlarged by using a halftone mask.

[0072] Drawing 16 shows the result of having calculated the depth of focus to the pattern size of an isolated omission pattern. It turns out that the depth of focus is improving by considering as 5ths lighting exposure compared with the case where it exposes with 4th lighting. by being alike furthermore and using a halftone mask shows that the depth of focus is improving further. Securing the depth of focus of 1.5 micrometers can be kept, and line breadth is understood that it is possible to make it thin to 0.41 micrometers by the halftone mask exposure by 5th lighting to the case of Cr mask exposure being [which is depended on 4th lighting] usually 0.45 micrometers. Moreover, it is possible by optimizing the magnitude of opening to raise the depth of focus further.

[0073] That is, it became possible for an isolated omission pattern to extract and to design line breadth more thinly, with the advantage of 4ths lighting exposure that minimum line width of last shipment of 1:1 can be designed thinly (about 0.3 micrometers) by considering as 5ths lighting exposure having. Consequently, it became possible for the so-called isolated omission-pattern with the thick Rhine width of face to extract to the tooth-space width of face which exists in an LSI pattern, and to design line breadth more thinly, and it became possible to attain shrink with a large chip size.

[0074] In addition, this invention is not limited to each example mentioned above, it is the range which does not deviate from the summary, and can deform variously and can be carried out. In an example, although the special diaphragm shown in drawing 2 and drawing 4 was used as a means to attain 4th lighting and 5th lighting, it is possible not to limit this invention, to use a fiber etc. for others, and to attain 4th lighting and 5th lighting.

[0075] Next, the 5th example of this invention is explained. Drawing 17 is the outline block diagram showing the projection aligner concerning the 5th example of this invention. It is condensed by the 1st condensing optical system 72, and the light generated from the light source 71 is led to the equalization optical system 73. As for the equalization optical system 73, an optical fiber, polyhedron prism, etc. may be used. Image formation of the light which came out of the equalization optical system 73 is carried out, and it forms the secondary light source. The filter 4 (the 1st eccentricity filter is called hereafter) which has aperture 81 is installed in the location which carried out eccentricity to this secondary light source location from the optical axis. Exposure light passes only the part of this aperture 81, and illuminates a reticle 76 through the 2nd condensing optical system 75.

[0076] The exposure light which passed the reticle 76 reaches on a wafer 79 according to projection optics 77. Although the pupil 78 which exists in projection optics 77 is usually circular opening, in this example, the slit-like filter (a pupil slit filter is called hereafter) is installed in the pupil location as illustration. The longitudinal direction of this slit is the same as the eccentric direction of the 1st eccentricity filter 74. this 1st eccentricity filter 74 and the pupil slit filter 78 have maintained the physical relationship of said publication -- the synchronous roll control circuit 80, the motor which is not illustrated -- a synchronization -- it is pivotable. One exposure is ended by rotating the 1st eccentricity filter 74 and the pupil slit filter 78 360 degrees in the synchronous roll control circuit 80.

[0077] The result of having calculated the focal margin to the pattern size in exposure with the projection aligner of this example is shown in drawing 18 . It is exposure by the example when a dotted line usually uses Cr mask usual in exposure (sigma=0.6) and a continuous line. In addition, NA of an aligner, the coherence factor sigma, and the exposure wavelength lambda are 0.55 and 0.6,365 nm, respectively. It does not depend for the result of drawing 18 in the direction of last shipment. Therefore, it turns out that this example solved the trouble mentioned above, the direction dependency of last shipment was abolished, and fast depth of focus increase is moreover usually attained compared with exposure. Moreover, the depth of focus of such fine last shipment improves that eccentricity from the optical axis of the core of aperture 81 is enlarged.

[0078] Thus, according to this example, the filter which has aperture 81 is arranged in the location which carried out eccentricity to the secondary light source location of an aligner from the optical axis, by the illumination-light study system and thing which illuminate a mask 76 from across, the high order diffracted light of a long last shipment pattern enters in the direction perpendicular to the eccentric direction at projection optics 77, and resolution improves. And the pattern direction dependency of resolution is cancelable by cutting positively the diffracted light generated from patterns other than the above-mentioned direction, and exposing a slit and a filter further, setting a revolving shaft as an optical axis and carrying out synchronous rotation 360 degrees by arranging in a pupil location the slit which doubled the eccentric direction of a filter with the longitudinal direction.

[0079] Moreover, according to this example, the improvement in resolution can be further aimed at by preparing the translucent section for attenuating the zero-order diffracted light as a pupil slit filter 78, as shown in drawing 19 . The light which came out of the 1st eccentricity filter 74 like drawing 19 illuminates a mask 76 from across. In the case of the last shipment pattern of 1:1, the transmitted light of a mask 76 diffracts and is mainly divided into the primary [**] diffracted light and the zero-order diffracted light. Zero-order light goes straight on and reaches a points of the pupil slit filter 78. Moreover, the +primary diffracted light reaches b points. - The primary diffracted light does not go into a pupil and does not participate in image formation. zero-order light -- the +primary diffracted light -- ****** -- since it is large, it is possible by making it decrease with a semi-transparent membrane 85 to raise resolution more. Although the semi-transparent membrane 85 was used in this example, what is necessary is just a means to attenuate only zero-order light.

[0080] Drawing 20 is the outline block diagram showing the 6th example of this invention. In addition, the same sign is given to the same part as drawing 17 , and the detailed explanation is omitted. The point that this example differs from the 5th example is the configuration of the light source filter with which the secondary light source is equipped.

[0081] namely, the light source filter in this example -- an optical axis -- inserting -- an object -- two aperture 81 and 82 is formed in the location (2nd filter is called hereafter). According to this example, although the resolving property is the same as the 5th example, ending, when one exposure rotates the 2nd filter 74 and the pupil slit filter 78 180 degrees in the synchronous roll control circuit 80 differ. If the quantity of light from the aperture 81 of the 5th example and the quantity of light from one aperture in this example are equal, since aperture will be set to two and angle of rotation will become half, the exposure time can be made into one half.

[0082] Drawing 21 is the outline block diagram showing the 7th example of this invention. In addition, the same sign is given to the same part as drawing 17 , and the detailed explanation is omitted. The points that this example differs from the 6th example are the configuration of the light source filter with which the secondary light source is equipped, and the configuration of the filter with which a pupil location is equipped.

[0083] That is, the light source filter in this example has formed four aperture 81, 82, 83, and 84 in the location of the symmetry 4 times to the optical axis (4th filter is called hereafter). Moreover, the filter of a pupil location has parallel-crosses-like opening (a pupil parallel-crosses filter is called hereafter). In addition, you may be the thing which prepared opening along the direction of the side of the rectangle which consists of the 4th like the above-mentioned parallel crosses that what is necessary is just opening which connects the 4th in a pupil location as a configuration of the filter of a pupil location, or the thing (in this case, it becomes cross opening) which prepared opening in the 4th direction of the diagonal line.

[0084] According to this example, the resolving property is almost the same as the 5th example, but ending, when one exposure rotates 4th filter and a pupil parallel-crosses filter 90 degrees in the synchronous roll control circuit 80 differ. If the quantity of light from the aperture of the 5th example and the quantity of light from one aperture in this example are equal, since aperture will be set to four and will become the angle-of-rotation drawings 1/4, the exposure time can be set to one fourth.

[0085] In the above 5th - the 7th example, although the filter of the shape of the shape of a slit and parallel crosses is installed in the pupil location of projection optics, in the protection-from-light part of this filter, exposure light is absorbed, it changes to heat, optical system is degraded, and the problem of affecting imprint precision greatly arises. Especially drawing 22 shows the concrete configuration of the pupil filter for solving the above-mentioned problem in the 5th and the 6th example. Drawing is a block diagram about a pupil slit filter. It is a mirror with [91 / slit] an inclination in 92. If exposure light carries out incidence to this pupil slit filter from a top, the exposure light which carried out incidence to the inclined mirror 92 will be reflected without being absorbed. The reflected exposure light is drawn out of optical system, and is absorbed by the absorber arranged out of optical system. Therefore, since exposure light does not change to heat in optical system, it does not degrade imprint precision.

[0086] Moreover, in the 5th - the 7th example, it becomes possible by applying a halftone phase shift mask as a mask to raise the depth of focus and resolution further. The imprint property when the dashed line of drawing 18 imprints using a halftone mask in addition to the three above-mentioned examples is shown. It turns out that the depth of focus is improving compared with the case where the usual Cr mask is used.

[0087] Moreover, in the above-mentioned example, when the halftone mask was exposed with 4ths lighting filter and the phase filter, it was shown that effectiveness is large, but even if it uses other phase shift masks, for example, a shifter edge mold phase shift mask, and a self-align mold phase shift mask, big effectiveness is acquired similarly. Furthermore, other mask structures of attaining the above-mentioned optical principle are sufficient.

[0088] Moreover, although the filter which has at least one aperture which carried out eccentricity from the optical axis was used in the 5th - the 7th example in order to determine the configuration of the secondary light source, this invention may not be limited and other approaches, such as a fiber, may be used.

[0089]

[Effect of the Invention] As explained in full detail above, according to this invention (claims 1-3), using 4th filter as the secondary light source, by using a halftone mask, a self-align mold phase shift mask, a shifter edge mold phase shift mask, etc. as a mask, when the size of a last shipment pattern is large, even if it is, the depth of focus can be enlarged enough, and improvement in exposure precision can be aimed at.

[0090] Moreover, according to this invention (claim 4), while using 4th filter as the secondary light source, by arranging a phase filter in the pupil location of projection optics, it cannot be dependent on pattern size and the big depth of focus and the improvement effectiveness in marginal resolution can be acquired. In addition, it is possible to use a halftone mask and a phase shift mask for a mask, and to enlarge the above-mentioned effectiveness more by things.

[0091] Moreover, according to this invention (claim 5), by using the special diaphragm which has the configuration of two kinds of filters of a zona-orbicularis lighting filter and 4ths lighting filter as the secondary light source, pattern size and the dependency of a direction can be reduced to the level which is satisfactory practically, and high definition ability and the improvement effectiveness in the depth of focus are acquired.

[0092] Moreover, according to this invention (claims 6-8), in addition to the depth of focus of the last shipment pattern in the case of exposing like claims 1-3 mentioned above, using 4th filter as the secondary light source, and the improvement effectiveness in marginal resolution, the depth of focus and resolution over an isolated omission pattern can also be raised by enlarging light source reinforcement near the core of the secondary light source. Consequently, it becomes possible to attain shrink with a large chip size. Moreover, according to this invention (claims 9 and 10), by carrying out synchronous rotation of the secondary light source and the pupil filter which have the aperture which carried out eccentricity, it does not depend in the direction of a pattern, but it becomes possible to enlarge the depth of focus enough.

[Translation done.]

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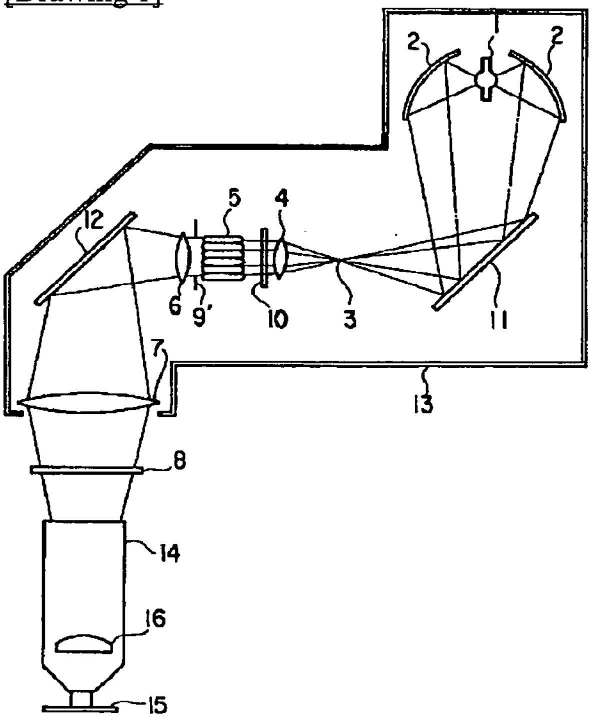
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]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9'
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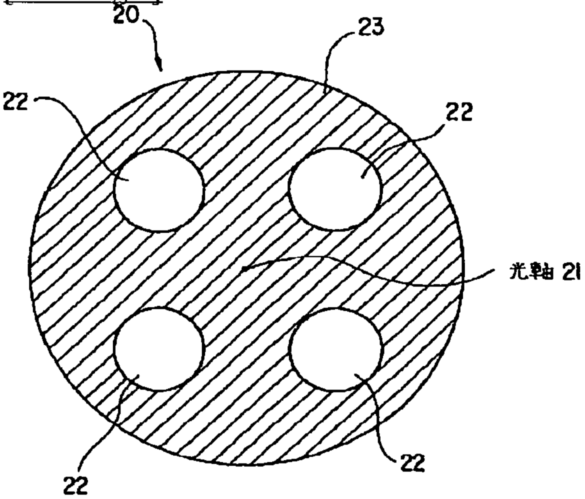
[Drawing 2]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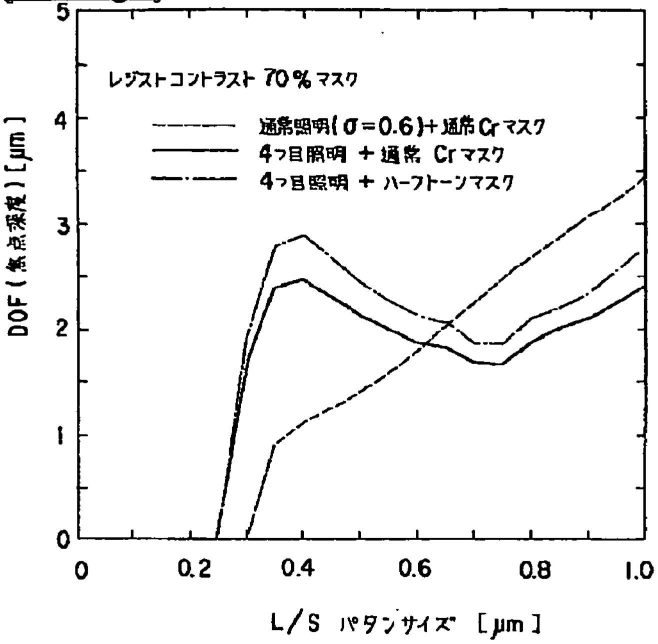
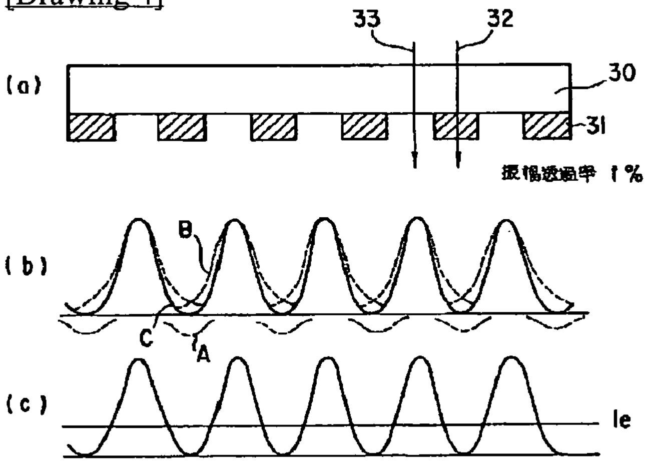
22
光軸 21
22
22

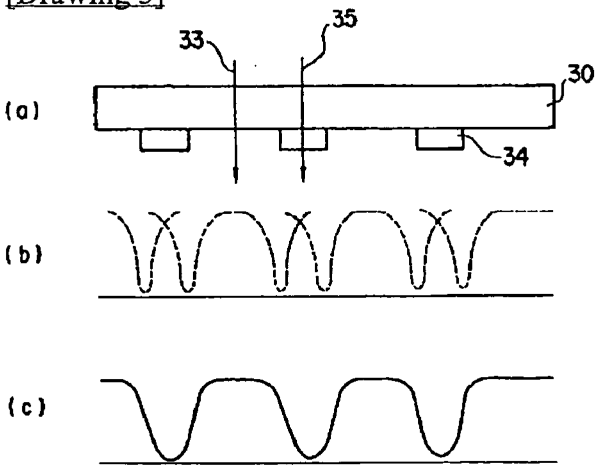
[Drawing 3]



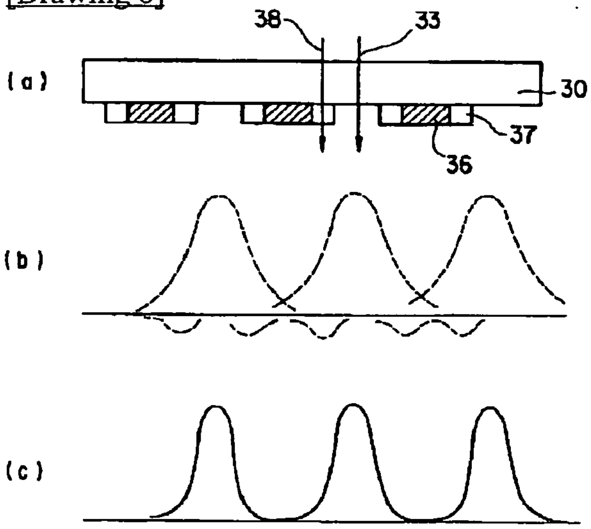
[Drawing 4]


33
32
(a)
30
31
振幅透過率 t%
(b)
B
C
A
(c)
Ie

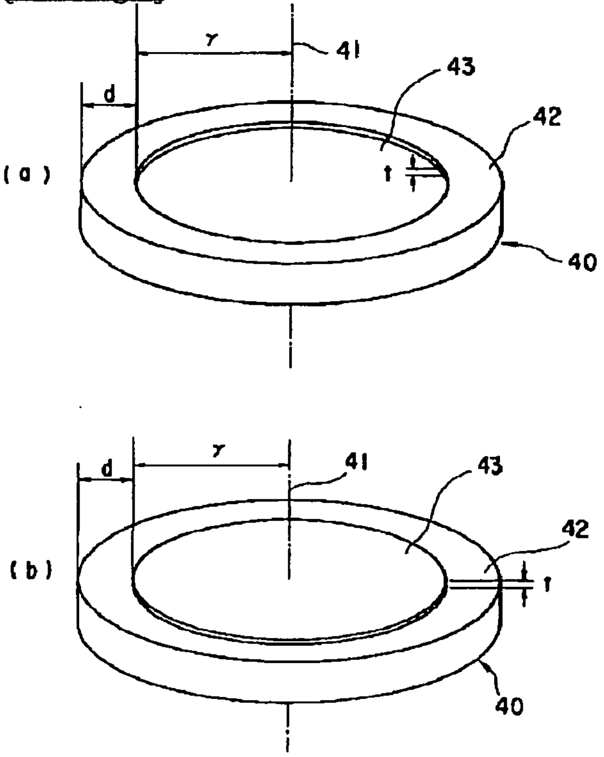
[Drawing 5]


33
35
30
(a)
34
(b)
(c)

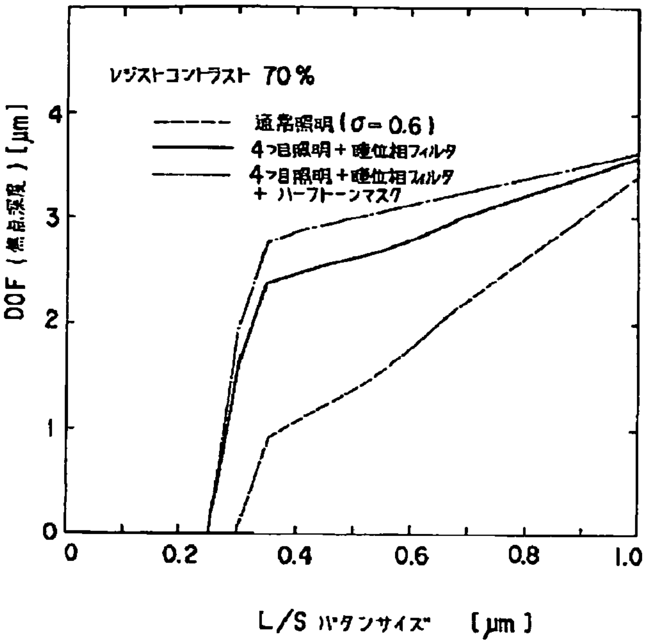
[Drawing 6]


38
33
(a)
30
37
36
(b)
(c)

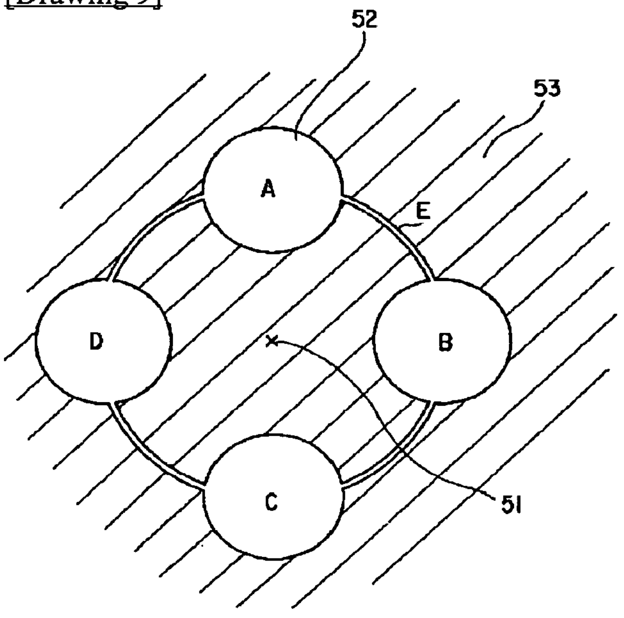
[Drawing 7]


r
41
d
43
42
(a)
t
40
d
r
41
43
42
(b)
t
40

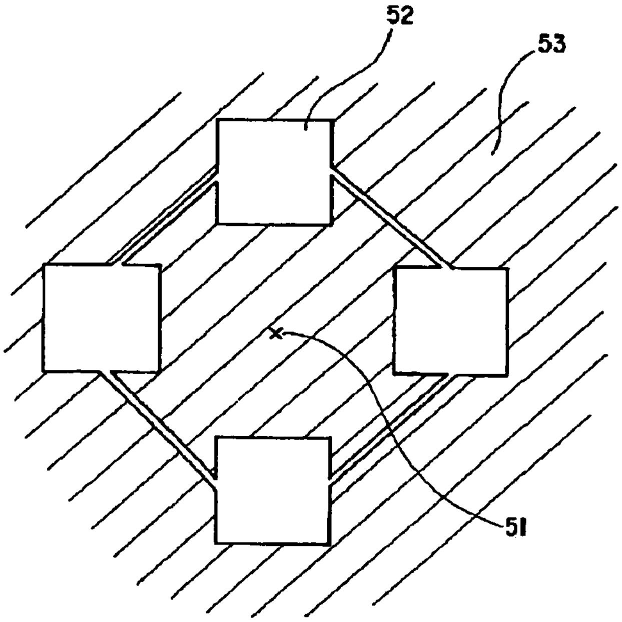
[Drawing 8]



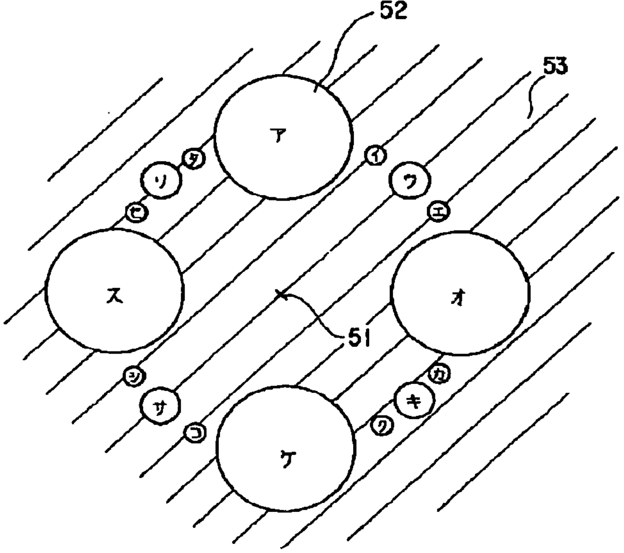
[Drawing 9]


52
53
A
E
D
B
C
51

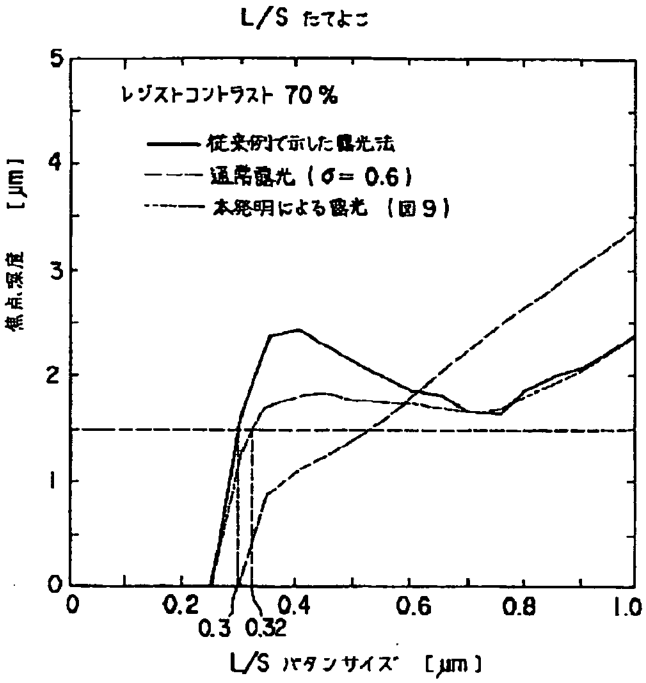
[Drawing 10]



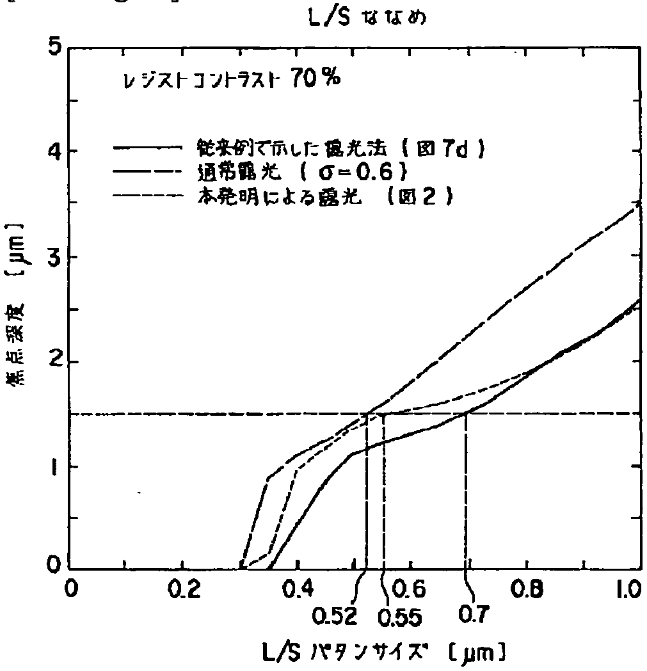
[Drawing 11]


52
53
ア
タ
リ
セ
イ
ウ
エ
ス
オ
51
シ
サ
コ
ケ
カ
キ
ク

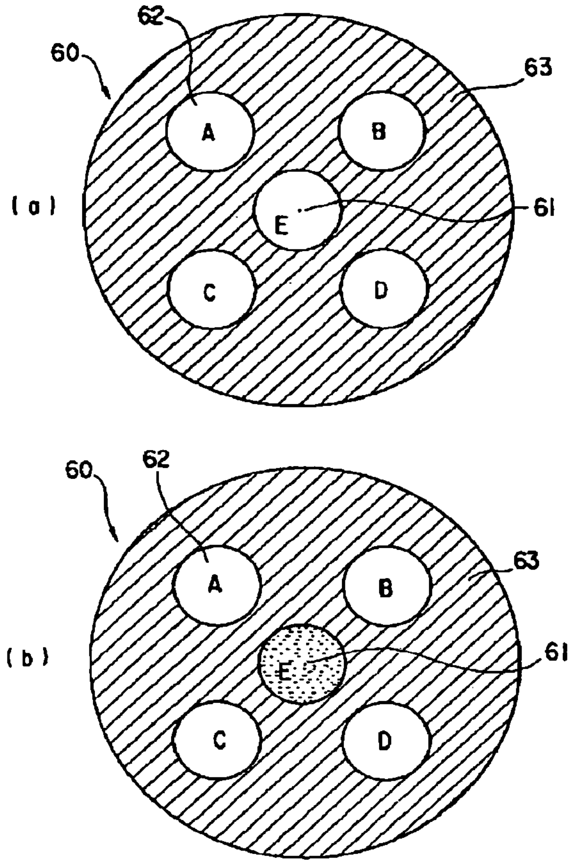
[Drawing 12]



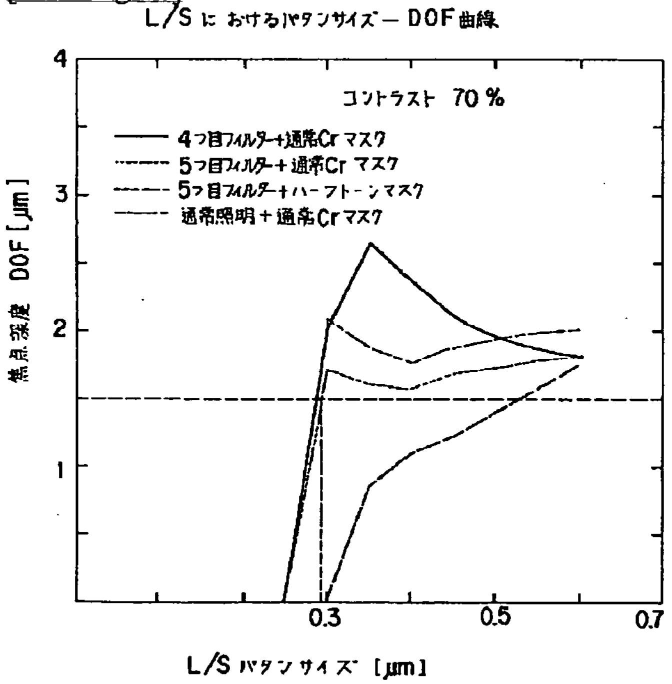
[Drawing 13]



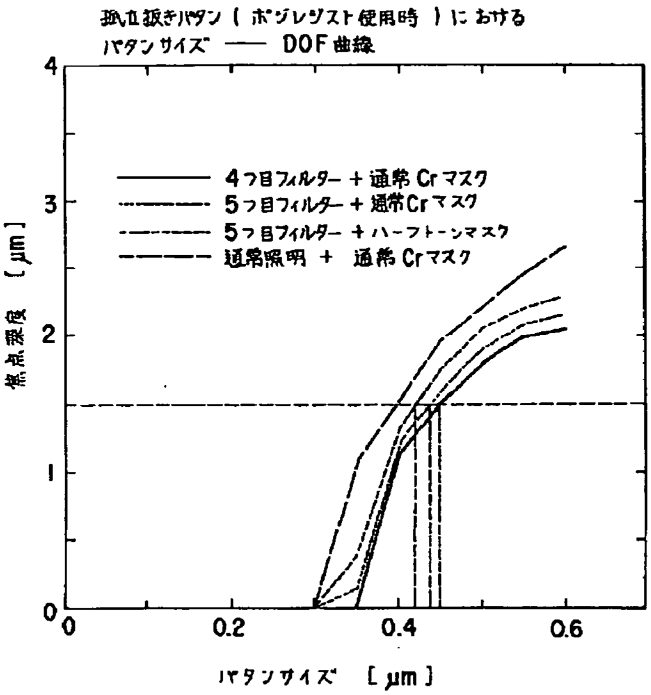
[Drawing 14]


60
62
63
A
B
E
61
C
D
(a)
60
62
63
A
B
E
61
C
D
(b)

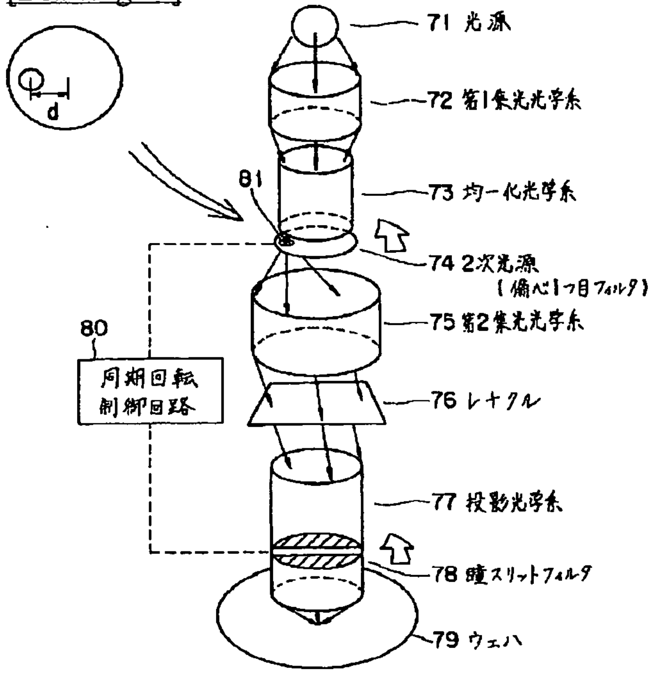
[Drawing 15]



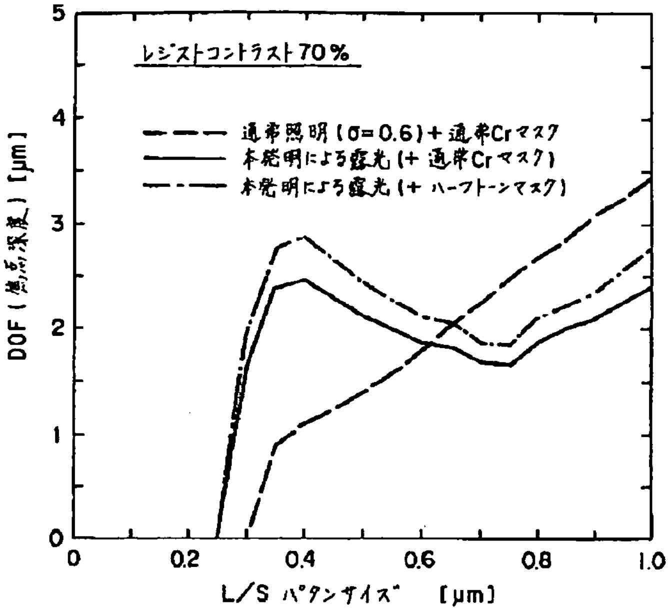
[Drawing 16]



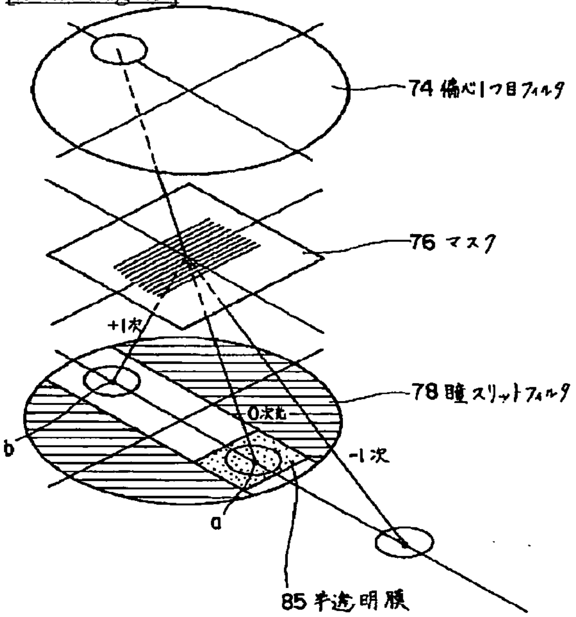
[Drawing 17]


d
81
80
周期回転制御回路
71 光源
72 第1集光光学系
73 均一化光学系
74 2次光源（偏心1つ目フィルタ）
75 第2集光光学系
76 レチクル
77 投影光学系
78 瞳スリットフィルタ
79 ウェハ

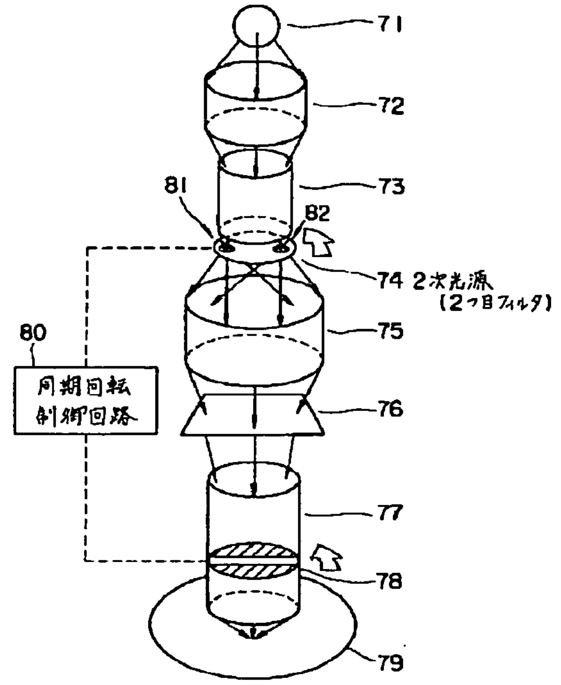
[Drawing 18]



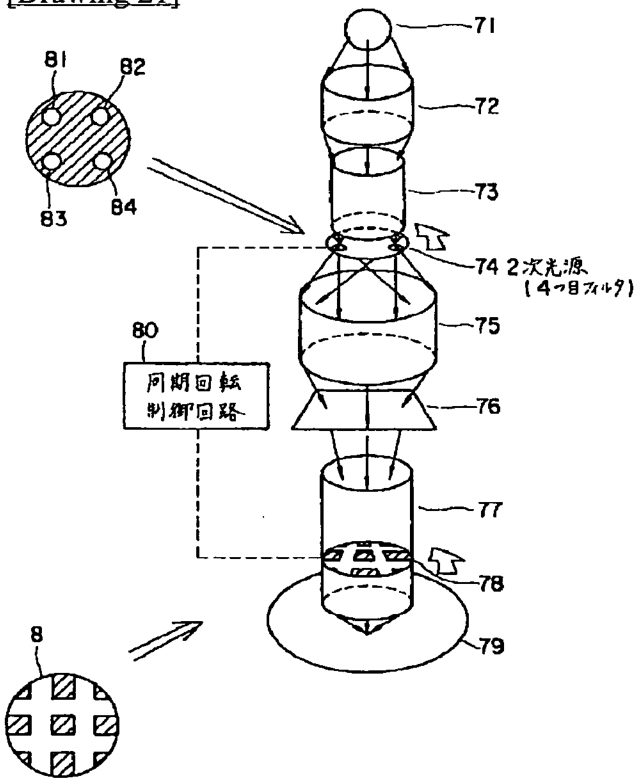
[Drawing 19]


74 偏心1つ目フィルタ
76 マスク
+1次
78 瞳スリットフィルタ
0次光
-1次
b
a
85 半透明膜

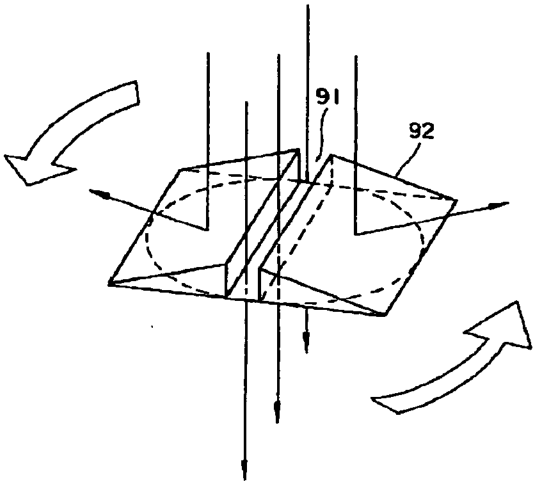
[Drawing 20]


71
72
73
81
82
74 2次光源 (2つ目フィルタ)
75
80
同期回転制御回路
76
77
78
79

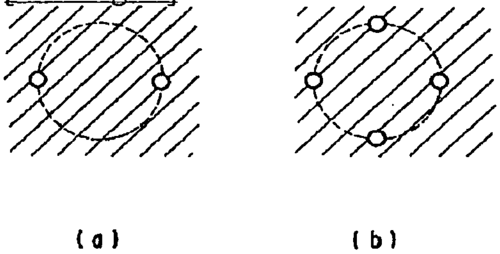
[Drawing 21]


81
82
83
84
71
72
73
74 2次光源 (4つ目フィルタ)
75
80
同期回転制御回路
76
77
78
79
8

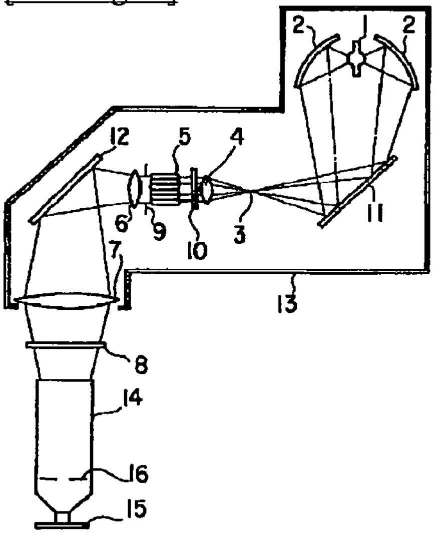
[Drawing 22]



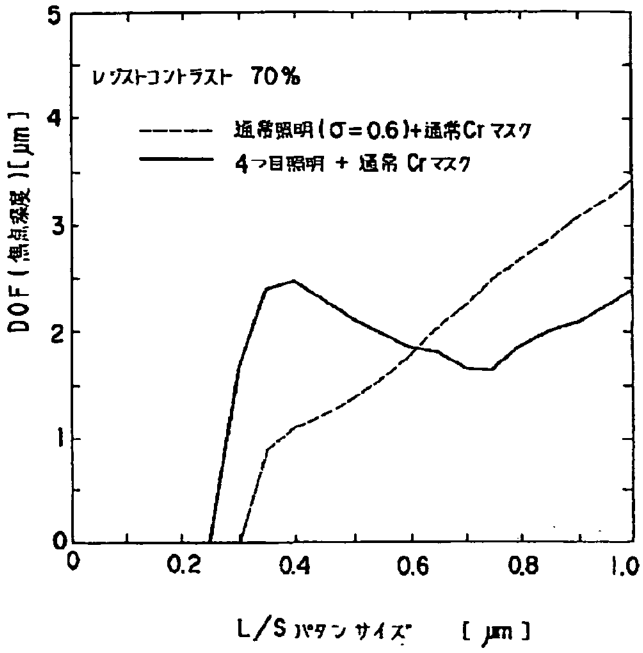
[Drawing 25]



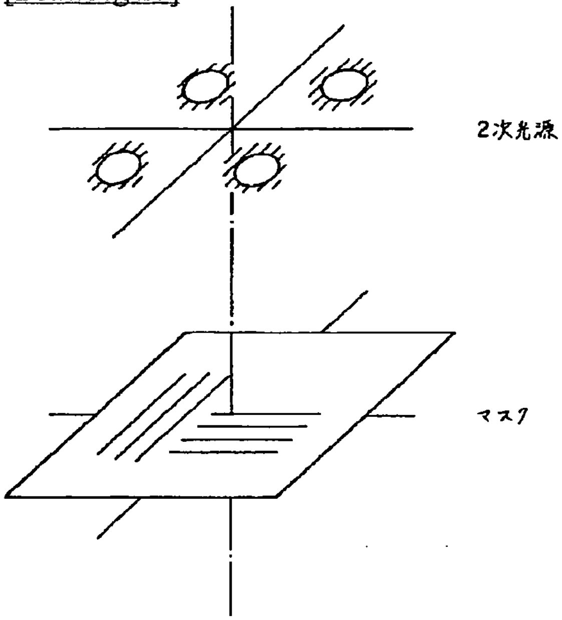
[Drawing 23]


2
1
2
12
5
4
6
9
10
3
11
7
13
8
14
16
15

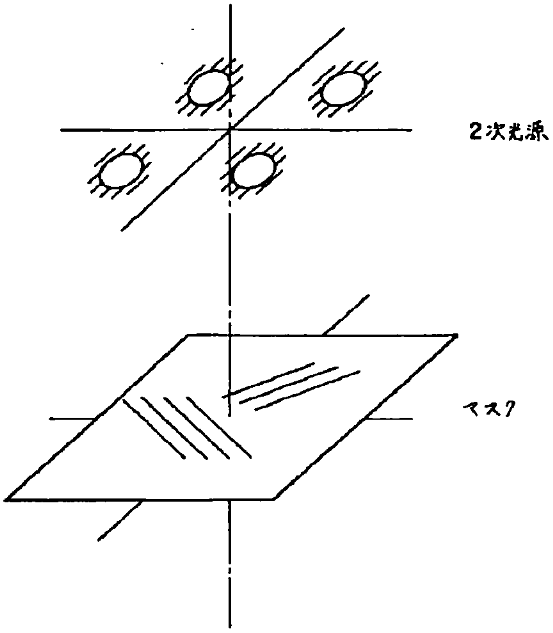
[Drawing 26]



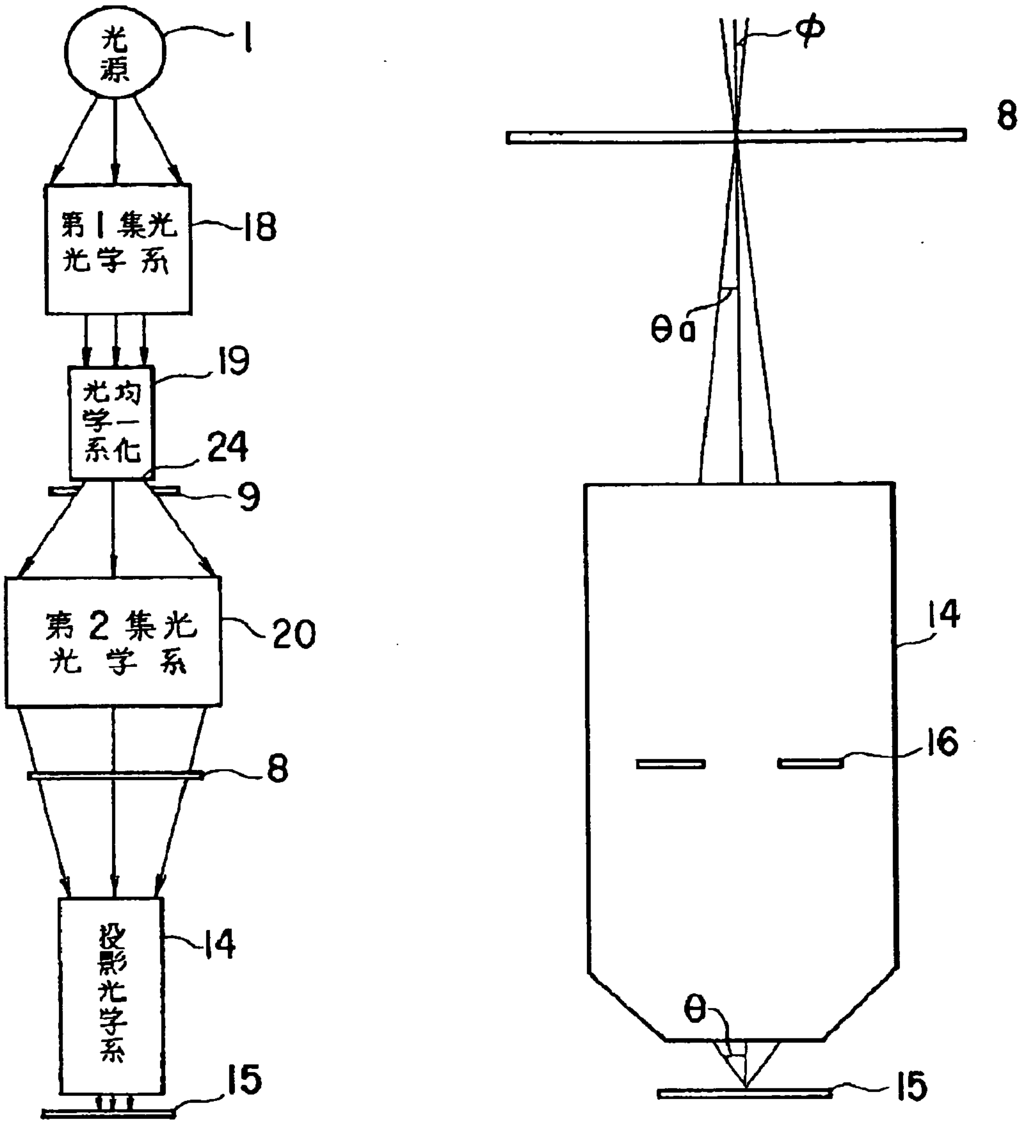
[Drawing 27]



[Drawing 28]

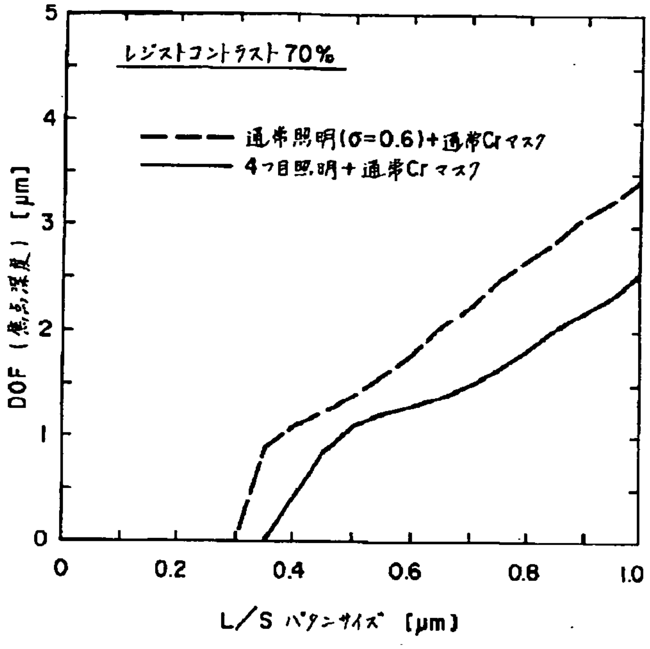


[Drawing 24]


光源
1
第1集光光学系
18
均一化光学系
19
24
9
第2集光光学系
20
8
投影光学系
14
15
φ
8
θa
14
16
θ
15

(a) (b)

[Drawing 29]



[Translation done.]